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XXVI.—*On the Typical Value of the Lingual Dentition in the right Distribution of the Genera of Gasteropoda into Natural Groups and Families.* By JOHN DENIS MACDONALD, M.D., F.R.S., Staff Surgeon, R.N.

[Plate XVI.]

THOUGH many of the weak points of pure conchology have been brought to light by the study of the lingual dentition of the Gasteropoda, there is yet much more to be accomplished, embracing not only the acquisition of new facts by further research, but the right use of those already in our possession. We are, even now, only sufficiently acquainted with the subject to know that any system of conchology, however plausibly framed, cannot be reliable where this important test has not been brought to bear. It is nevertheless true that the import of the dental characters has been either misinterpreted or not sufficiently taken into account in some of our best works on malacology. It is scarcely to be believed, for example, that, as at present received, the greater number of the genera of the two significant families Muricidæ and Buccinidæ require reciprocal change of place, the truth of which position will be demonstrated as we proceed with the inquiry.

Mr. Jabez Hogg, in a paper* lately read before the Microscopical Society, quotes a passage from Mr. S. P. Woodward's 'Manual of Mollusca,' that I had already transcribed for my own purpose some eight or nine years ago; but, as that purpose does not appear to be infringed upon by the tenor of Mr. Hogg's reasoning, I shall still adopt the quotation in question, as affording a good idea of the commonly received views of classification by the lingual dentition (*op. cit.* p. 450):—

* "On the Lingual Membrane of Mollusca, and its value in Classification," by Jabez Hogg, F.L.S. &c., published in the 'Quarterly Journal of Microscopical Science,' No. 31, July 1868.

“The patterns or types of lingual dentition are on the whole remarkably constant, but their systematic value is not uniform. It must be remembered that the teeth are essentially epithelian cells, and, like other superficial organs, liable to be modified in accordance with the wants and habits of the creatures. The instruments with which animals obtain their food are of all others the most subject to those adaptive changes, and can never form the basis of a philosophical system.” And I add here a note from the bottom of page 450 :—“The carnivorous opossums have teeth adapted for eating flesh, but are not on that account to be classed with placental carnivora.”

To state that the *systematic value* of the types of lingual dentition is not uniform implies, first, that we are fully acquainted with a subject which is yet avowedly only in its infancy; and, secondly, that from this knowledge notable instances may be advanced demonstrating the truth of the assertion. We are surely not to form a hasty conclusion to this effect from the analysis of such a family as the Bullidæ, for example, including a mass of beings differing as much *inter se* as the families of Pteropoda, and much more than the three acknowledged families of Heteropoda do. Now the principle which I desire to maintain is that Gasteropoda whose general anatomical characters, including the configuration, sculpturing, and minute structure of their shells, suggest their distribution in the same group will be found still further to be associated as well as distinguished by the type and peculiarity of their lingual dentition—moreover, that *prima facie* resemblance or difference, with or without conformity in the dentition of the animals, may only require a little further investigation to reveal their natural affinities or antipathies. Anticipating myself a little, I think I may safely state, from extended observation, that *Concholepas*, *Purpura*, *Ricinula*, *Vitularia*, or any other genus properly referable to the Muricidæ will always be found with a lingual dentition unequivocally on the type of that of *Murex*. But if some *Pisania*, *Ranella*, *Triton*, *Fasciolaria*, and other equally incongruous genera are associated with them, it is no wonder that the dentition should be found to exhibit no “uniform systematic value.” For further illustration we may select the Buccinidæ, whose dental characters are so distinctive that any single genus properly belonging to it can never be confounded with Muricidæ or any other family. The excellent authorities Forbes and Hanley (vol. iii. p. 388), speaking of the genus *Nassa*, remark that “it is one of the best marked and most easily recognized groups, both as to shell and animal, among the Muricidæ (!), though some conchologists strangely persist

in mingling it with *Buccinum*." The buccinoid type of ribbon is nevertheless invariably found with *Nassa*, *Cyclonassa*, *Pusiosstoma* (Sw.), *Myristica*, and numerous other genera strictly appertaining to the family. But if *Ricinula*, *Planaxis*, *Cassis*, *Columbella*, and *Oliva* are placed in the same category, the dental characters will assuredly be found wanting; for the genera just mentioned cannot, with any justice to zoological science, be distributed into less than five distinct families apart from Buccinidæ.

I conclude therefore that, until all the families of the Gasteropoda have been sifted in this way, superfluous families rejected and nature's own families found, we cannot be in a position to affirm that the dental characters are not in all cases to be depended upon—though this may be in reality quite true.

If it is intended, by the assertion that the "teeth are essentially epithelian cells," to lessen their morphological importance and convey the idea of mutability, surely we ought to be able to draw a distinction between the normal and abnormal development of the same organs in different members of the same species. Moreover the teeth are formed from a special matrix at the fundus of the lingual sac, determining in every case the constant evolution of certain characters; and any defect in the formative pulp will repeat any consequent malformation in each succeeding row of teeth.

If it is implied that, as it were, obedient to circumstances affecting adaptation, nature may possibly give a buccinoid ribbon to a veritable *Murex*, such a doctrine is quite untenable. My own impression is that the distinctive characters of the teeth are in accordance with a definite plan, whether we associate this with the adaptation of the creatures to the special conditions of their existence or not. Any one finding *Helicina* (a truly terrestrial Nerite) and *Helix* (an inoperculate bisexual snail, with a broad lingual pavement) feeding in a tropical forest under precisely similar circumstances, would be inclined to yield the palm to the plan rather than to the conditions of existence. On Mr. Darwin's beautiful hypothesis, the divergence of species from a primitive type may be readily admitted; yet, like the coloured components of white light diverging from the prism, it would be unphilosophical to suppose them capable of reciprocally interchanging their characters and properties, even if it were possible to refer all to a common source.

No one would approve of establishing the peculiarities of the dentition of Mammalia or of any other great class of animals as a kind of ready reckoner of affinities, without taking into

account all other important structural particulars. Using a similar mode of reasoning to that adopted by Mr. Woodward, it might be said that although the dentition and habits of the pteropods *Creseis* and *Hyalæa* are obviously carnivorous, they are not on this account to be classed with the whelks or any other carnivorous Gasteropoda; nor, indeed, should they. But for this I will contend, that the dental characters are of equal importance in the discrimination of the Opossum from the Bandicoot, *Clio* from *Pneumodermon*, and of *Murex* from *Buccinum*, and that the genuine gasteropodous families are to be distinguished by their teeth, subordinate to certain broader features of structure, including union or distinctness of the sexes.

The question as to the actual number of rows of teeth occurring in any particular genus or species ought not to supersede the consideration of other characters afforded by them; for it is just possible that the typical number forming part of the morphological plan of the family may be rendered obscure by suppression and modified development in minor types. I endeavoured on a former occasion to set forth this principle, and I have since found abundant proof of its correctness. Here, indeed, it may be assumed that there is a want of uniformity; but, as even this appears to be amenable to fixed laws, the defect is more likely to be in our own philosophy than in the institutions of nature. The dental formula of *Conus*, *Terebra*, and *Pleurotoma* may be assumed to be a *single series* of fangs in each pleura, with a naked central space, characterizing the Toxifera of Dr. Gray; yet when in *Clavatulula* we find five rows of dental organs arranged as though the teeth of *Mitra* had been inserted between those of *Bela* or *Mangelia*, we recognize a primary and two minor types, depending upon the suppression of the central or the pleural teeth, as the case may be. Other examples of suppression of one or more of the members of the typical ribbon are to be found amongst the Turritellidæ and the Lamellariadæ. It is also of importance to observe the manner in which the dental processes are connected with the basal plates, and in particular whether they are recurved from the fore part of those plates or arise near or from their posterior border, in which latter case the teeth are not recurved, but point directly backwards. Thus the words *recurved* and *direct* would sufficiently express the two principal conditions here indicated, the dental points being in all cases retrorse. As a general rule, the teeth are recurved in the vegetable feeders, and direct in the carnivora. Simple fanged teeth, or those without foliations, are carnivorous, whether disposed in the manner of a

pavement, as in *Ianthina* or *Scalaria*, or in the pleuræ of a lingual ribbon, as in *Atlanta* and *Carinaria*. There are, however, mixed characters in the dentition of some genera; and the subject requires much careful study to elicit all that may be deducible from it as a guide to classification.

It would be very desirable to establish a fixed nomenclature for the parts, and some uniform mode of description of the lingual apparatus, so that the dental characters of any species referred to the fixed types shall be definite and unequivocal.

I have already employed Prof. Huxley's excellent name "odontophore" for the tooth-bearing membrane, with its expanded alæ in front embracing the tip of the tongue and being continuous with the lining membrane at the sides of the oral cavity, the posterior tubular portion of this organ, named the lingual sac, carrying the teeth upon its floor, extending backwards to the closed extremity containing the dental pulp or formative matrix, and forwards over the tip to the frænum of the tongue. The upper wall of the lingual sac terminates anteriorly in a crescentic fold, by which it becomes continuous with the lining of the œsophagus. The fore part and body of the tongue proper is supported by lateral cartilages wrapped together by muscle and ligament at the mesial line, and often having smaller supplementary pieces moveably articulated in front, as in the *Turbos* and *Nerites*. The cartilages in the carnivorous families in particular conjointly form a grooved surface, over which the odontophore glides when in action. The common dental area or the space occupied by the teeth is usually divided into three lesser longitudinal areas, a central and two lateral, commonly known as rachis and pleuræ. The latter name may be retained; but the "central dental area," though longer, is preferable to "rachis," which is not sufficiently definite.

The *central area* usually presents a median series of dental plates, either alone or with one or more lateral series. The median series, however, is often suppressed. The pleuræ may present one, two, three, or many longitudinal rows of teeth; and these are numbered, from within outwards, first, second, third, &c.

With what has been already said of the basal plates and dental processes connected with them, this brief anatomical sketch will answer all practical purposes. The special types of dentition will be noticed when the groups or families which they characterize come under consideration.

Having completed the foregoing introductory remarks, I

shall now attempt the grouping of all the genera which I have found (in many cases by repeated personal observation) referable either to Buccinidæ or Muricidæ, substantiating my position by satisfactory proof and reference to the labours of others, furnishing decisive evidence in authentic preparations, figures, and descriptions.

In order that there should be no possible mistake in the types of the two very distinct forms of dentition to which I refer, I have selected two examples for each, viz. those of *Buccinum undatum* (Pl. XVI. fig. 1, odontophore laid flat) and *Cassidulus melongena* (fig. 2) for Buccinidæ, and those of *Murex tenuispina* (fig. 3) and *Concholepas peruviana* (fig. 4) for Muricidæ.

BUCCINIDÆ.

Lingual dentition triserial, the distinctive feature of which is a stout conical fang at the inner extremity of the pleural plates.

Systematic Name.	References and Remarks.
<i>Buccinum undatum</i>	Preparations and drawings, fig. 1.
— <i>cyaneum</i>	Gray's 'Guide to Mollusca,' p. 22, referring also to Lovén, t. 5. f. 5.
<i>Cantharus undosus</i>	Personal observation in Fiji, and an excellent preparation in Mr. Barron's collection.
<i>Pisania striata</i>	Personal observation in the Mediterranean; description, Gray, <i>op. cit.</i> p. 13.
<i>Pusiostoma mendicaria</i>	Personal observation and preparation.
<i>Cominella maculosa</i> , & } two undetermined sp. }	Figured by Hogg, <i>op. cit.</i> pl. 10. fig. 33; description, Gray, p. 16.
<i>Chrysodomus antiquus</i>	Forb. & Hanl. vol. iii. p. 427, fig. 31; Gray, fig. 9, p. 13; Mr. Barron's preparations.
— <i>propinquus</i>	F. & H., description, vol. iii. p. 420.
— <i>islandicus</i>	Ibid. p. 419, pl. SS. fig. 2 c; Mr. Barron's preparations.
— <i>gracilis</i>	Figured by Hogg, plate 10. figs. 32 & 34.
<i>Nassa reticulata</i> } — <i>annulata</i> } — <i>incrassata</i> } — <i>arcularia</i> }	Description of dentition, Gray, p. 17, and Lovén's figures, t. 5.
— <i>badia</i>	Mr. Barron's preparations.
<i>Neritula neritacea</i>	Ditto.
<i>Cassidulus melongena</i>	Personal observation at Jamaica, preparations and drawings.
— <i>morio</i> } — <i>nodosus</i> } — <i>vespertilio</i> }	Gray, fig. 6, p. 10, where also the dentition of <i>C. nodosus</i> and of <i>C. vespertilio</i> is described.
<i>Triumphis distorta</i>	Description, Gray, p. 15.

Bullia and *Phos* are, in all probability, also members of this family; but only those genera or, more critically, those species have been introduced whose *Buccinoid* character has been determined by their lingual dentition, either actually figured or satisfactorily described. The list already includes some of the principal genera, and will, no doubt, be soon very considerably augmented when the information and research of other naturalists is brought to bear upon it in the manner above indicated.

MURICIDÆ.

Lingual dentition triserial, the distinctive feature of which is having strongly curved *simple* acuminate teeth in the pleuræ; and the origins of the central teeth are usually in bold relief upon the basal plates.

Systematic Name.	References and Remarks.
<i>Murex tenuispina</i>	Personal observation, preps. and drawings.
— <i>trunculus</i>	Figured by Hogg, <i>op. cit.</i> pl. 10. fig. 35.
— <i>brandaris</i>	Mr. Barron's preparations.
— <i>erinaceus</i>	Forbes & Hanley, pl. TT. fig. 1 <i>c.</i>
<i>Purpura lapillus</i>	Mr. Barron's preparations; descrip. Gray, p. 20.
— <i>Blainvillii</i>	Mr. Barron's preparations.
— <i>hæmastoma</i>	Figured by Hogg, pl. 10. fig. 36.
<i>Iopas Francolina</i>	Mr. Barron's preparations.
<i>Trophon bamfium</i>	F. & H. pl. SS. fig. 3 <i>b.</i>
— <i>magellanicus</i>	Mr. Barron's preparations.
— <i>clathratus</i>	F. & H., description of axile tooth.
<i>Monoceros imbricatum</i>	Figured by Troschel.
— <i>brevidentatum</i>	Mr. Barron's preparations.
<i>Vitularia fiscellum</i>	Description, Gray, p. 19.
<i>Rapana</i>	Characters of genus, Gray, p. 19.
<i>Muricidea</i> (<i>Sw.</i>)	Personal observation in the South Seas.
<i>Fusus</i> or <i>Colus proboscidalis</i>	I have found the dentition of this species to be as follows:—Axile plates broad, with a large central tooth, and a smaller one on either side of it. Pleural teeth simple, uncinatè.
<i>Hemifusus</i> or <i>Cochlidium tuba</i>	Dr. Gray's description, p. 11 ("Teeth central, 3-toothed, lateral, hooked, versatile") may be contrasted with the above.

The present state of the two families to which I have confined my attention in this paper shows the utter impossibility of classifying the Gasteropoda by the purely conchological method of comparing shell with shell, independently of the light which we now know may be derived from the dental characters. On applying to the systems of Gray, Woodward, and Adams the plummet of the foregoing lists, it will be found that, though they differ considerably *inter se*, they all

differ more strikingly from the plummet, as shown in the following table :—

BUCCHINIDÆ determined by the Lingual Dentition.	System of Gray*.	System of Woodward†.	System of H. & A. Adams‡.
Buccinum	Buccinum	Buccinum	Buccinum
Cantharus	"	"	"
Pisania	"	"	"
Pusiostoma	"	"	"
Cominella	"	Cominella	Cominella
Chrysodomus	"	"	"
Nassa	"	Nassa	Nassa
Neritula	"	Cyclonassa	Neritula
Cassidulus	"	"	"
Triumphis	"	"	"
MURICIDÆ.			
Murex	Murex	Murex	Murex
Purpura	"	"	"
Iopas	"	"	"
Trophon	Trophon	Trophon	Trophon
Concholepas§	"	"	"
Monoceros	"	"	"
Vitularia	"	"	Vitularia
Rapana	"	Rapana	"
Muricidea	"	"	Muricidea
Fusus or Colus proboscidualis	"	"	"
Hemifusus or Cochlidium tuba	"	"	Hemifusus (<i>Sw.</i>)
Sistrum§	"	"	"

Were all the genera included in each system given *in extenso*, a very much greater difficulty would present itself to the mind of any one attempting to reconcile their differences. Enough has been said, however, to show that the lingual dentition would appear to be the only appeal. Indeed the effort to accomplish this desirable object in any other way would only lead to unscientific dispute, and develop no satisfactory result.

In a subsequent paper I shall consider the relationships of all the families of probosciferous Gasteropoda in which the central and often the pleural teeth point directly backwards without recurvature—in short, the Orthodontal Proboscifera.

Haslar Hospital, Sept. 11, 1868.

* Guide to Mollusca, vol. i.

† Manual of Mollusca.

‡ Genera of Mollusca.

§ Omitted in Muricidæ above.